Food Technology Research Journal, Vol. 5, issue 1, 63-74, 2024

FTRJ

Producing Yoghurt of High Nutritional and Healthy Value Supplemented With Zucchini Flower

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Original Article

Article information

Received 18/7/2024

Revised 12/8/2024

Accepted 25/8/2024

Published 29/8/2024

Available online 01/09/2024

Keywords

Zucchini flower, yoghurt, nutritional and healthy value

ABSTRACT

This study investigated the effect of incorporating zucchini (*Cucurbita pepo L.*) flowers on the nutritional and sensory properties of yogurt during refrigerated storage (4±1°C) for 3 weeks. Fresh and stored yogurt samples were assessed for chemical composition (total solids, protein, fat, ash, minerals), pH, diacetyl content, antioxidant activity, total phenols, carotenoids, texture (hardness, springiness, cohesiveness, gumminess, chewiness), and sensory attributes (flavor, body & texture, appearance). Results showed that ash content increased gradually in all yogurt samples during storage. Yogurts with zucchini flowers had higher mineral contents compared to the control. The initial pH of all samples was acidic in the first week, and then gradually decreased with storage time. Yogurt with 2.5% zucchini flowers exhibited the highest diacetyl content. Zucchini flower addition significantly increased antioxidant activity, total phenols, and carotenoids compared to the control. Hardness, cohesiveness, gumminess, and chewiness increased with increasing zucchini flower levels, while springiness decreased. Sensory evaluation revealed that yogurts containing 1, 1.5 and 2% zucchini flowers received higher scores for flavor, body & texture, and appearance than the sample containing 2.5 % zucchini flowers. These findings suggest that zucchini flowers have potential as a functional food ingredient, enhancing the nutritional and sensory properties of yogurt

1. Introduction

Yogurt is a globally popular fermented milk product produced by adding a starter culture containing *Lactobacillus delbrueckii ssp*. bulgaricus and Streptococcus thermophiles to milk. It is renowned for its nutritional value, including a significant amount of bioavailable calcium. Beyond its essential nutrients, yogurt offers various health benefits such as improved lactose tolerance, potential weight and fat loss advantages, and the positive effects of probiotic bacteria. In recent years, consumer eating habits have shifted towards healthier options, with a growing demand for foods rich in micronutrients. Organic vegetables and grains are natural sources of these essential elements. Zucchini, a widely available vegetable worldwide, is a popular choice due to its nutritional content. Moreover, edible flowers, including zucchini flowers, have gained prominence in the global market as consumers seek foods with unique flavors and nutritional benefits. Zucchini flowers are particularly recognized in Mexico, India, and parts of the USA as a traditional edible flower. Edible flowers, including zucchini flowers, offer a range of health benefits, such as improved antioxidation, immune function, and overall biological activities. Research by Xia and Wang (2007) indicates their potential to enhance the human immune system. Beyond their health benefits, edible flowers are prized for their aesthetic appeal, unique flavors, and nutritional value. They are used in various culinary applications, from garnishing dishes to creating innovative flavors in meals and beverages. Edible flowers are prized for their aesthetic appeal, unique flavors, and nutritional value. They are used in various culinary applications, from garnishing dishes to creating innovative flavors in meals and beverages. Edible flowers can be prepared in numerous ways, including canning, boiling, frying, grilling, or freezing. They can also be incorporated into a variety of foods and drinks, such as tea, ice cream, sorbets, cocktails,

Journal website: https://ftrj.journals.ekb.eg/

Published by Food Technology Research Institute, ARC

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salads, melted cheese, and honey (Guine et al., 2021). All the listed parts of the zucchini (seeds, fruits, and flowers) are edible and contain nutrients that give them specific health- promoting properties (Gbemenou et al., 2022). Edible flowers are increasingly becoming an integral part of the human diet. They are a good source of antioxidant compounds, which are a very important component of one's daily diet (Navarro et al., 2015). The nutritional potential of edible flowers is very high. The health benefits associated with the consumption of edible flowers are believed to be due to the content of natural bioactive compounds with pro-health properties, including phenolic acids; flavonoids; anthocyanins; and other phenolic compounds with proven antioxidant, antimicrobial, and antibacterial properties (Purohit et al., 2021). Since ancient times, zucchini flowers have been eaten locally as a vegetable in Mexico and India (Halder and Khaled, 2021). Zucchini flowers considered as agriculture wastes. Even though its contain high different quantities of nutrients and bioactive components. They contain many ingredients that have a beneficial effect on the human body. These compounds include polyphenols, phytosterols, carotenoids, mono- and polyunsaturated fatty acids, vitamin C and E, and selenium (Zhou et al., 2017). These compounds show many pharmacological activities, such as antitumor, antigenotoxic, antimutagenic, antibacterial, and anti-inflammatory, are also used in the treatment of diseases caused by oxidative stress, (Batool et al., 2022). Zucchini flowers, in their composition, contain many bioactive ingredients that have a beneficial effect on the human body. Therefore, this work was designed to study the effect of adding zucchini flowers to yogurt.

2. Materials and Methods

Chemical composition of buffalo's milk and zucchini flowers powder

Parameters	Buffalo's Milk	Zucchini flowers powder
Total solid%	14.48	91.0
Fat%	5.60	2.26
Protein%	3.75	23.0
Ash %	0.7	15.8
Carbohydrate%	-	35.1
Lactose %	4.5	-
Fiber %	-	14.8
PH values	6.68	6.64

Preparation of zucchini flowers

Flowers zucchini were obtained from the local market and rinsed in distilled water and dried at 40 C^0. The dried flowers were ground.

Preparation of yoghurt

Buffalo's milk obtained from faculty of Agriculture, Cairo University. Yoghurt was produced according to Tamime and Robinson, (2007). Fresh buffalo's milk was heated to 80ºC for 10 min., then cooled to 4ºC and heated to 42ºC, and inoculated with a 2% yoghurt starter (*Streptococcous thermophiles and Lactobacillus delbrueckii subsp. bulgaricus*) was added. Yoghurt milk was fortified with 1, 1.5, 2 and 2.5 % (w/w) of zucchini flowers. After adding the zucchini flowers, the yogurt mix was incubated in 100 ml cups at 42°C until set, and then stored at 4±1°C for 3 weeks. Samples were analyzed throughout storage to assess the impact of zucchini flower addition on their properties. Control yoghurt was prepared without additions of zucchini flowers.

Chemical analysis

Yoghurt samples were analyzed for moisture, ash, fiber and fat contents as outlined in AOAC (2019). Protein content was determined according to the method described by Bradley et al. (1992). Carbohydrate was calculated. Antioxidant activity and Total phenols content (TPC) were measured according to Okonogi et al. (2007). Carotene in yoghurt samples was determined according to the method described by Carvalho et al. (2012).

A digital laboratory jenway 3510 pH meter, UK. Bibby Scientific LTD was used to measure pH values. The measurement of titratable acidity was according to Caric et al. (2000). Mineral content analysis employed atomic absorption spectrophotometer NO.3300 (PerkinElmer, US Instrument Division, Norwalk, CT, USA) following the method described by Mohamed et al. (2011). Acetaldehyde and Diacetyl were determined using the method outlined by Guler and Gursoy -Balci (2011)

Textural properties Analysis

Texture profile analysis (TPA) was performed on yoghurt samples using an Instron Universal Testing Machine (model 1195, Stable Micro System (SMS) Ltd., Godalming, UK, loaded with Dimension Software SMS program.) according to the procedure of Bourne (1982).

Color measurement

Color of yogurt samples was analyzed using a Konica Minolta CR1 10 colorimeter (Konica Minolta Solutions Ltd., Basildon, UK). The measurements were conducted under artificial light to minimize daylight effects. The L* (lightness), a* (red/green), and b* (yellow/blue) color parameters of the yogurt samples were evaluated according to the International Commission on Illumination (CIE) L*a*b* system.

Viscosity measurement

Viscosity, which is one of the main factors affecting acceptability of yoghurt. The viscosity of yoghurt samples was measured using the Brookfield Engineering Labs DV III ultra rheometer, Inc., Stoughton, MA, USA, according to Petersen et al. (2000).

Microbiological analysis

MRS Agar was used for enumeration of *Lactobacillus bulgaricus* and M17 Agar was used for *Streptococcus thermophiles*. These cultures are used as bacterial medium for determination of yoghurt starters' growth and viability (Lawrence et al., 2015). Coliform was counted using violet red bile agar as described in Hitchins (1992). Yeast and mold were detected according to IDF (1990).

Sensory evaluation

The organoleptic properties were evaluated as given by Tamime and Robinson (1999), while flavor was scored out of 60-point body & texture 30 points and appearance of 10 points. The organoleptic properties were assessed by 20 panelists from the staff of Food Technology Research Institute, Agricultural Research Center, Ministry of Agriculture.

Statistical analyses

The data obtained from the three replicates were subjected to statistical analysis using the General Linear Model (GLM) procedure in SAS software (SAS, 1990). Duncan's multiple range test was then employed to identify significant differences among the means.

3. Results and Discussion

Chemical composition

Table 1 show that the addition of zucchini flowers with different concentrations resulted in a slight increase in the total solids content of fresh yogurt samples. This may be due to the higher percentage of total solids in zucchini flowers. Supplementation with 1%, 1.5%, 2% and 2.5% zucchini flowers led to a significant increase in Ash content compared to the control yoghurt this is likely due to the higher level of Ash in the zucchini flowers compared to milk, similar observations were reported by Ismail, et al. (2016) and Ammar et al. (2015).

Mineral contents

Fermented dairy products are widely consumed due to their nutritional value and health benefits. However, they may lack certain essential minerals, like iron, which plays a crucial role in the immune system (Jakopovi et al., 2022). Table1 demonstrates that the yogurt treatments with zucchini flowers had higher levels of minerals (iron, sodium, potassium, and calcium) compared to the control yogurt. Furthermore, the mineral content increased with increasing concentrations of zucchini flowers. This aligns with research by Dhawi et al. (2020), who reported elevated levels of dietary minerals, particularly sodium and potassium, in zucchini flowers.

Table 1. Chemical composition and minerals of yoghurt samples during storage period.

Component %	Storage period weeks	T1	T2	T3	T4	T5
	Fresh	$14.75^{A,B}$	$14.82^{A,B}$	$15.81^{A,A}$	$15.98^{A,A}$	$16.12^{A,A}$
Total solids	1	$14.78^{A,B}$	$14.88^{A,B}$	$15.83^{A,A}$	$15.99^{A,A}$	$16.18^{A,A}$
	2	$14.88^{A,B}$	$14.89^{A,B}$	$15.86^{A,A}$	$16.11^{A,A}$	$16.21^{A,A}$
	3	$14.91^{A,B}$	$14.93^{A,B}$	$15.89^{A,A}$	$16.15^{A,A}$	$16.24^{A,A}$
Protein	Fresh	$4.61^{A,A}$	$4.69^{A,A}$	$4.72^{A,A}$	$4.75^{A,A}$	$4.79^{A,A}$
	1	$4.65^{A,A}$	$4.70^{A,A}$	$4.74^{A,A}$	$4.78^{A,A}$	$4.81^{A,A}$
	2	$4.66^{A,A}$	$4.71^{A,A}$	$4.76^{A,A}$	$4.79^{A,A}$	$4.83^{A,A}$
	3	$4.69^{A,A}$	$4.74^{A,A}$	$4.78^{A,A}$	$4.79^{A,A}$	$4.85^{A,A}$
Fat	Fresh	$4.8^{A,C}$	$4.8^{A,C}$	$4.9^{A,BC}$	$5.1^{A,AB}$	$5.3^{A,A}$
	1	$4.8^{A,B}$	$4.9^{A,B}$	$4.9^{A,B}$	$5.1^{A,AB}$	$5.3^{A,A}$
	2	$4.8^{A,B}$	$4.9^{A,B}$	$4.9^{A,B}$	$5.1^{A,AB}$	$5.3^{A,A}$
	3	$4.8^{A,B}$	$4.9^{A,B}$	$4.9^{A,B}$	$5.1^{A,AB}$	$5.3^{A,A}$
Ash	Fresh	$0.85^{C,C}$	$0.89^{B,BC}$	$0.91^{B,AB}$	$0.95^{B,A}$	$0.95^{B,A}$
	1	$0.88^{BC,B}$	$0.91^{AB,AB}$	$0.94^{AB,A}$	$0.95^{B,A}$	$0.96^{B,A}$
	2	$0.91^{AB,B}$	$0.93^{AB,B}$	$0.97^{A,A}$	$0.98^{AB,A}$	$0.99^{AB,A}$
	3	$0.93^{A,C}$	$0.95^{A,BC}$	$0.97^{A,BC}$	$1.00^{A,AB}$	$1.03^{A,A}$
Ca		1.32	1.47	1.58	1.67	1.75
Na(mg/g)	Fresh	0.57	0.68	0.74	0.79	0.88
K		2.15	2.33	2.42	2.51	2.61
Fe		0.15	0.19	0. 21	0.24	0.25

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively
The letters before comma possess the factor of the storage period. While those after comma possesses the factor of zucchini flowers level. The means with the same letter did not significantly differ

pH value

As highlighted by Salij and Ismail, (1983), pH measurement is a valuable tool for monitoring yogurt acidity during refrigerated storage. The results observed that initially exhibited an acidic pH during the first week. However, the pH gradually decreased, becoming more acidic with extended storage time. The changes in pH for all yogurt samples throughout storage are presented in Table 2. This continuous decline in pH across all samples, including the control, is likely linked to increased lactic acid production due to the ongoing acidification process – the primary mechanism during yogurt fermentation (Aloğlu and Öner 2011; Nguyen and Hwang 2016). Furthermore, the decreasing pH can be interpreted as an indicator of high metabolic activity by the lactic acid bacteria, the starter culture commonly used in yogurt production (Zainoldin and Baba 2009).

Table 2. Effect of zucchini flowers on pH value of yoghurt samples during storage period

Storage period weeks	T1	T2	T3	T4	T5
		pH value			
Fresh	$4.68^{A,A}$	$4.65^{A,A}$	$4.62^{A,A}$	$4.60^{A,A}$	$4.60^{A,A}$
1	$4.57^{A,A}$	$4.52^{AB,A}$	$4.40^{AB,A}$	$4.39^{AB,A}$	$4.33^{AB,A}$
2	$4.50^{AB,A}$	$4.45^{AB,AB}$	$4.36^{AB,AB}$	$4.30^{B,AB}$	$4.25^{B,B}$
3	$4.32^{B,A}$	$4.29^{B,A}$	$4.25^{B,A}$	$4.25^{B,A}$	$4.18^{B,A}$

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively.
The letters before comma possess the factor of the storage period. While those after comma possesses the factor of zucchini flowers level. The means with the same letter did not significantly differ.

Microbiological examination

Table 3 shows the counts of thermophiles and lactobacillus, it can be noticed that Fresh yogurt samples exhibited a range of 6.66 to 6.89 log colony-forming units (CFU) per gram for *Streptococcus thermophilus* and 7.56 to 7.62 log CFU/g for lactobacilli. These counts also increased during storage period and reaching a maximum at 7 days before declining. The initial increase could be attributed to the stimulating effect of zucchini flowers, which contain ingredients that promote bacterial growth. Meanwhile, the higher counts of Streptococcus and Lactobacillus may be due to zucchini flowers containing carbohydrates and dietary fiber, which are considered prebiotics. These data were in agreement with Zaky et al. (2013) and Mehdizadeh et al. (2019). Comparing previous data Table 3 it can be found that enriched treatments with zucchini flowers gained higher counts compared to control due to their richness in carbohydrates, which enhance the growth of starter cultures. These findings are in harmony with the results obtained by Mehdizadeh et al. (2019) and Al-Shawi (2020). Generally, yoghurt of all treatments was free from coliform and yeast & mold.

Table 3. Effect zucchini flowers on total bacterial count log cfu/gm of yoghurt sample during storage period and mould and yeast

Storage period weeks	Treatments				
	T1	T2	T3	T4	T5
Streptococcus thermophiles (Log cfu/g)					
Fresh	6.66	6.63	6.83	6.78	6.89
1	6.78	6.93	6.90	6.82	6.98
2	6.56	6.85	6.78	6.67	6.66
3	6.45	6.51	6.28	6.32	6.31
lactobacillus bulgaricus (Log cfu/g)					
Fresh	7.56	7.60	7.62	7.55	7.62
1	7.62	7.65	7.86	7.86	7.89
2	7.53	7.40	7.43	7.52	7.45
3	7.46	7.25	7.32	7.38	8.39

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively

Color properties

As shown in Table 4, yogurt containing zucchini flowers exhibited a bright color ranging from yellow to orange. This is reflected in the L^* values (80.49% - 84.54%), which indicate a lighter color compared to the control yogurt. The positive a^* values (-3.41% to -0.76%) indicate a slight red or orange hue, likely due to the pigments present in zucchini flowers. This is further supported by the high b^* values (6.70% - 11.46%), signifying a strong yellow color contribution from the flowers (Itle and Kabelka 2009). The carotene content of the yogurt samples is also reflected on the color properties of the samples. Yogurt fortified with zucchini flowers show a positive a^* value which signifies red color, whereas for both control the axis coordinate is negative.

Table 4. Color parameters of zucchini flower and treatments of yoghurt

Color parameters	Yoghurt samples					
	Plant sample	T1	T2	T3	T4	T5
L^*	52.93	84.45	84.54	81.60	81.95	80.49
a^*	9.08	-3.41	-2.36	-2.02	-1.06	-0.76
b^*	33.78	6.70	7.77	8.98	9.01	11.46

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively.
L^* value represents lightness to darkness (100-0).
a^* value represents color ranging from red (+) to green (-).
b^* value represents yellow (+) to blue(-).

Acetaldehyde and diacetyl contents

Table 5 reveals that the addition of zucchini flowers influenced the levels of diacetyl and acetaldehyde in the yogurt samples, potentially affecting flavor. The amount of diacetyl was higher in yoghurt with 2.5% zucchini flowers sample than other samples and had a comparable value for control yogurt, 2.5 % zucchini flower -added yoghurt had a higher diacetyl content than other samples and the control. This may explain the effect of zucchini flowers on the production of yoghurt flavor. Yogurt containing 1% zucchini flowers had the greatest acetaldehyde value compared to other samples with comparable acetaldehyde values, the control sample had the lowest acetaldehyde value. This indicates that the yoghurt samples with zucchini flowers had higher acetaldehyde production.

This suggests that there was more acetaldehyde produced in the yoghurt samples containing zucchini flower. It was demonstrated to have an impact on how acetaldehyde and diacetyl developed in each sample. Because alcohol dehydrogenase converts acetaldehyde to ethanol, acetaldehyde levels in certain yoghurt samples dropped (Ertekin and Guzel-Seydim 2010). Such an effect was observed by Hussein et al. (2011). These results were in line with Hamdy et al. (2021). The development of diacetyl and acetaldehyde levels was due to the metabolic activity of starter cultures in the presence of Zucchini flowers (Aljewicz et al., 2020).

Table 5. Acetaldehyde & diacetyl contents of fresh Yoghurt samples

Parameter	Yoghurt samples				
	T1	T2	T3	T4	T5
Acetaldehyde (µmol/100 g)	17.50	34.50	33.75	30.67	28.92
Diacetyl (µmol/100 g)	11.33	12.00	15.00	21.00	23.00

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively

The Impact of Zucchini Flowers on Yogurt Viscosity

Viscosity, a crucial property influencing the flow resistance of food, plays a significant role in the texture and mouthfeel of yogurt. As demonstrated in Table 6, fortifying yogurt with zucchini flowers at various concentrations led to a noticeable increase in viscosity compared to the control yogurt. This enhancement is likely due to the higher water-holding capacity of zucchini flowers, attributed to their greater content of solids and fibers. All yogurt samples, including the control, exhibited a gradual increase in viscosity over the 21-day storage period. This finding is consistent with previous research by El-Shreef et al. (2015) and Melnyk et al. (2020). Notably, yogurt fortified with zucchini flowers displayed an even more pronounced increase in viscosity throughout storage. This can be attributed to their higher total solids content and the presence of crude fibers, which act as effective thickening agents with a superior water-binding capacity compared to the control yogurt. These results align with the findings of Narayana & Gupta (2018) and Tizghadam et al. (2021).

Table 6. Effect of zucchini flowers on viscosity of yoghurt samples

Viscosity	Yoghurt Samples				
Storage period	T1	T2	T3	T4	T5
Fresh	2121	2385	3645	3729	4348
3 weeks	2841	2911	3956	3919	4733

Textural properties analysis

Moisture content plays a major role in case of textural properties. One popular technique for evaluating the textural characteristics of food products is profile analysis. The textural qualities (hardness, adhesiveness, cohesiveness, springiness, gumminess, and chewiness) of fresh and stored yoghurt enhanced with zucchini flowers at 5 ±1°C for a maximum of 21 days are presented in Table 7. Compared to the control yogurt, both fresh and stored samples with zucchini flowers exhibited significantly increased textural attributes. The hardness values, in particular, showed a pronounced rise with increasing zucchini flower concentration. This can be attributed to the higher total solids content in yogurt containing zucchini flowers. Additionally, yogurt's pH directly impacts curd texture by influencing casein solubility. As the pH decreases, the hardness increases. These findings are in line with studies by Ares et al. (2006), El-Shreef et al. (2015), El-Sayed & Youssef (2019) and Bulut et al. (2021). Cohesiveness values followed the same trend of hardness, with increasing zucchini flowers levels. The results suggested that the internal structure of zucchini flowers yoghurt was bonded, and the bonds were stronger to break during the first compression than control without added zucchini flowers (Fox et al., 2017). Also, the data in Table 7 showed that the gumminess and chewiness values were higher in all zucchini flowers treatments compared to the control (El-Taweel et al., 2017).The springiness values decreased gradually by increasing the ratios of zucchini flowers in yoghurt samples.

Table 7. Effect of zucchini flowers on Textural Profile analysis of Yoghurt samples

Treatments	Hardness	Adhesiveness	cohesiveness	Springiness	Gumminess	Chewiness
			Fresh			
T1	4.2	0.829	0.38	5.32	2.2	7.22
T2	5.0	0.956	0.38	5.30	2.4	8.80
T3	5.9	1.510	0.43	4.86	2.6	10.52
T4	6.1	1.554	0.48	4.73	2.7	12.39
T5	7.1	1.595	0.53	4.33	2.8	14.46
			7 DAYS			
T1	5.9	0.962	0.46	4.84	2.7	10.53
T2	6.3	0.982	0.47	4.73	2.9	12.19
T3	6.4	1.066	0.49	4.65	3.1	13.32
T4	6.5	1.137	0.51	4.64	3.1	13.58
T5	6.5	1.151	0.53	4.36	3.3	14.15
			14 DAYS			
T1	5.6	0.538	0.50	4.73	3.1	12.19
T2	6.4	0.720	0.52	4.59	3.2	13.85
T3	6.8	0.793	0.53	4.42	3.5	15.59
T4	7.1	1.009	0.55	4.42	3.5	15.92
T5	8.8	1.096	0.55	3.59	3.6	16.65
			21 DAYS			
T1	6.1	0.637	0.53	5.74	3.9	13.25
T2	7.2	0.821	0.55	5.43	4.2	14.75
T3	7.2	0.983	0.58	5.25	4.5	15.93
T4	8.8	1.213	0.62	5.21	4.6	16.91
T5	9.7	1.386	0.62	4.92	4.6	17.21

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively.

Total Phenol Content of Yogurt with zucchini flowers

Total phenol contents in yoghurt samples containing zucchini flowers were higher than in the control Table 8. An increase of total phenols was observed for all treatments yogurts, (Piljac-Žegarac et al., 2009). For instance, proteolysis of milk proteins may release amino acids with phenolic side chains, such as tyrosine, which could contribute to the increase in total phenol content. In addition, the metabolism of phenolic compounds by the yogurt cultures may include flavonoid glycoside hydrolysis or C-ring cleavage and the release of simple phenolics such as phenolic acids (Premalatha et al., 2016) and Korhonen, 2009).

Table 8. Antioxidants activity and Total Phenol and Carotene Contents of Yoghurt samples

Sample	Total phenol l%	Antioxidants %	Carotene %
T1	0.0277	40.2857	0.1204
T2	0.0296	53.7143	0.1356
T3	0.0307	57.7143	0.1373
T4	0.0314	59.2857	0.1438
T5	0.0435	60.5714	0.1678

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively

Organoleptic properties

Table 9 indicates that the sensory properties of yoghurt were affected by the addition of zucchini flowers and storage period. Yoghurt containing 1, 1.5 and 2% zucchini flowers had higher scores for flavor, body & texture and appearance than the sample containing 2.5% zucchini flowers**.** At the end of storage (21 days) all samples decreased this due to the increase of acidity development. These results are in accordance with those of El-Alfy et al. (2018), similar results were reported by Das and Seth (2017).

Table 9. Effect of zucchini flowers on organoleptic properties of all treatments during storage period

Treatments	Flavor (60)	Body & Texture (30)	Appearance (10)	Total (100)
		Fresh		
T1	59	29	10	$98^{A,A}$
T2	59	29	10	$98^{A,A}$
T3	58	29	10	$97^{A,A}$
T4	58	28	9	$95^{A,A}$
T5	57	28	9	$94^{A,A}$
		7 DAYS		
T1	59	29	10	$98^{A,A}$
T2	58	28	10	$96^{AB,AB}$
T3	58	28	10	$96^{AB,AB}$
T4	57	28	9	$94^{AB,B}$
T5	57	27	9	$93^{A,B}$
		14 DAYS		
T1	58	28	10	$96^{A,A}$
T2	58	28	9	$95^{AB,A}$
T3	58	27	9	$94^{BC,AB}$
T4	57	27	9	$94^{AB,AB}$
T5	57	26	8	$91^{AB,B}$
		21 DAYS		
T1	57	27	9	$93^{B,A}$
T2	56	27	9	$92^{B,AB}$
T3	56	27	8	$91^{C,AB}$
T4	56	27	8	$91^{B,AB}$
T5	55	26	8	$89^{B,B}$

T1: control, T2, T3, T4 and T5: mixed zucchini flowers added in ratios 1, 1.5, 2 and 2.5% respectively.The letters before comma possess the factor of the storage period. While those after comma possesses the factor of zucchini flowers level. The means with the same letter did not significantly differ.

4. Conclusions

Zucchini flowers, rich in natural antioxidants like phenolic acids, flavonoids, and carotenoids, were explored for their potential as a yogurt functional food ingredient. Adding zucchini flowers to yogurt increased its total phenolic and carotenoid content, suggesting enhanced antioxidant capacity. Yogurt texture also improved with increased hardness, cohesiveness, gumminess, and chewiness. Sensory evaluation revealed favorable scores for yogurt with 1%, 1.5% and 2% zucchini flower concentrations. These findings highlight zucchini flowers as a promising functional food ingredient for yogurt enrichment, with further research recommended to explore the long-term stability of these bioactive compounds within yogurt and their potential health benefits in human studies.

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